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Dated 24 November 2003

Patents Form 1/77

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The Patent Office

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P01/7700 0.00-0321326.1

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference — P03986GB

2. Patent application number *(The Patent Office will fill this part in)* — 0321326.1 — 11 SEP 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   UVGI SYSTEMS LIMITED
   47 CENTRAL AVENUE
   WEST MOLESEY
   SURREY KT8 1QZ

   Patents ADP number *(if you know it)* — 8712267001

   If the applicant is a corporate body, give the country/state of its incorporation — GB

4. Title of the invention

   CONTROL OF ENVIRONMENT

5. Name of your agent *(if you have one)*

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   LAURENCE SHAW & ASSOCIATES
   Metropolitan House, 1 Hagley Road
   Edgbaston
   Birmingham B16 8TG

   Patents ADP number *(if you know it)* — ~~13623001~~ 7779002002

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
GB	0224427.5	21.10.02
GB	0224897.9	25.10.02

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute *(see note f)*

Number of earlier UK application	Date of filing *(day / month / year)*

8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request? — Yes

   Answer YES if:
   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.

   Otherwise answer NO (See note d)

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9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form	
Description	11
Claim(s)	0
Abstract	0
Drawing(s)	45 + 5 See mine attached

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	
Request for a preliminary examination and search (Patents Form 9/77)	
Request for a substantive examination (Patents Form 10/77)	
Any other documents (please specify)	

11. I/We request the grant of a patent on the basis of this application.

Signature(s) LAURENCE SHAW & ASSOCIATES Date Sep 1, 03

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom LAURENCE SHAW : 0121 454 4962

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered YES in part 8, a Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) Part 7 should only be completed when a divisional application is being made under section 15(4), or when an application is being made under section 8(3), 12(6) or 37(4) following an entitlement dispute. By completing part 7 you are requesting that this application takes the same filing date as an earlier UK application. If you want the new application to have the same priority date(s) as the earlier UK application, you should also complete part 6 with the priority details.

Agents Ref
P0 3986GB

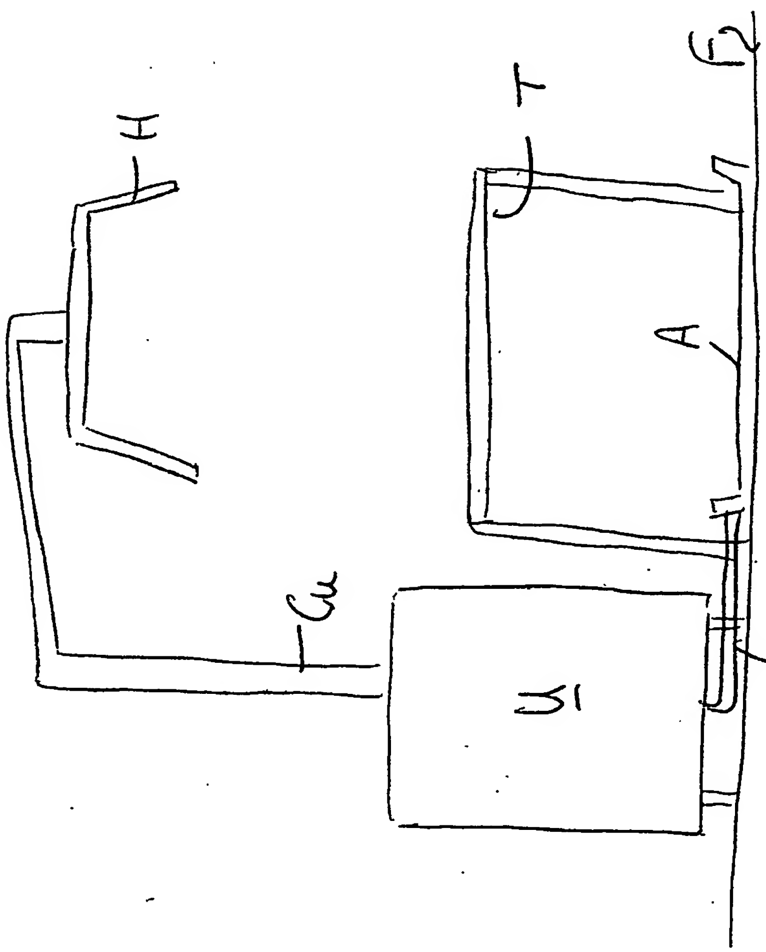

Fig 1

~~1/4~~ 2/5

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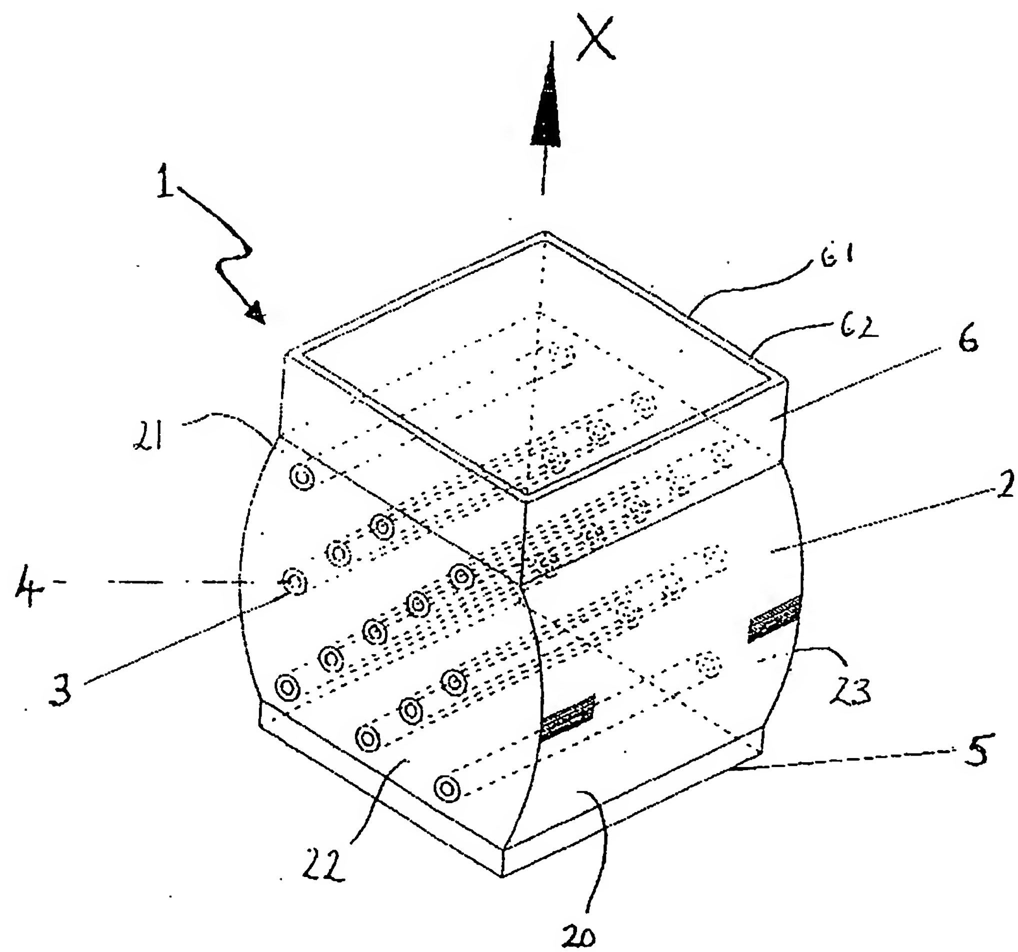

~~Figure 1~~ 2

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P03986GB

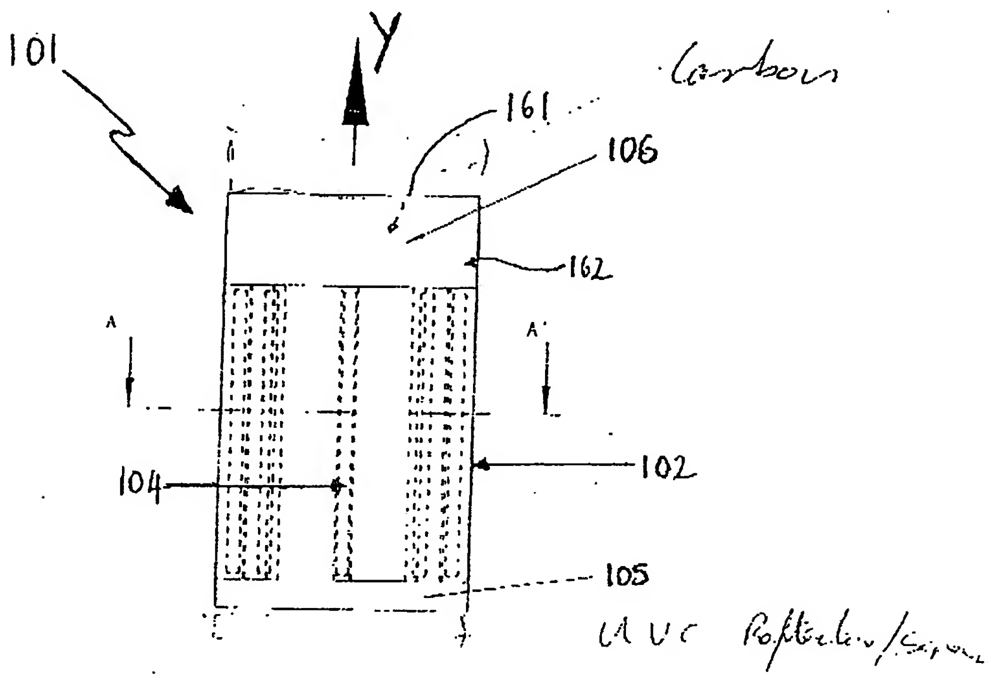

Figure 2A

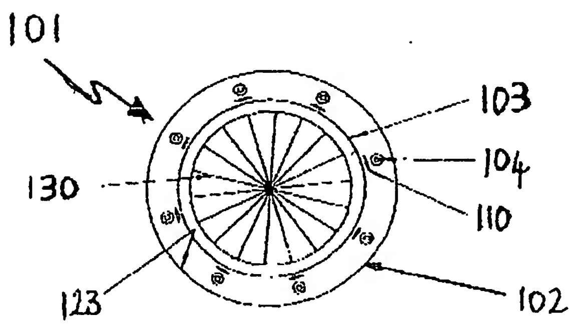

Figure 2B

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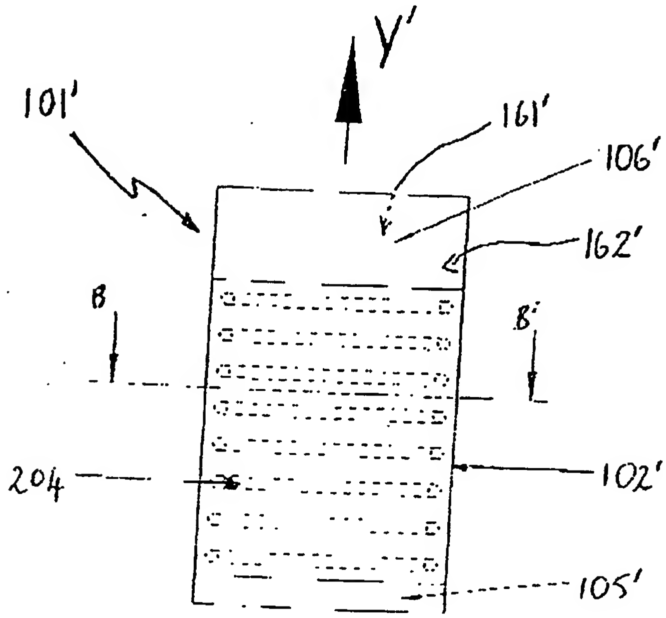

FIGURE 3A

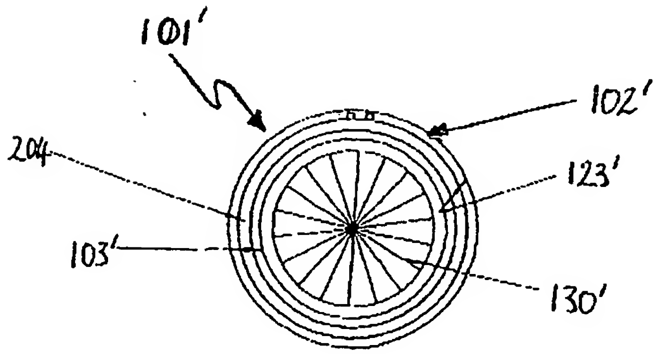

FIGURE 3B

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~~4/4~~

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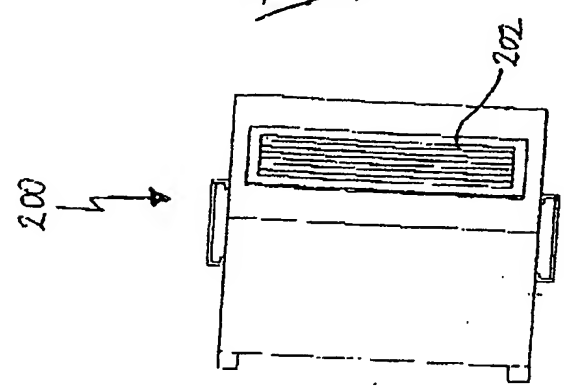

FIGURE 4C

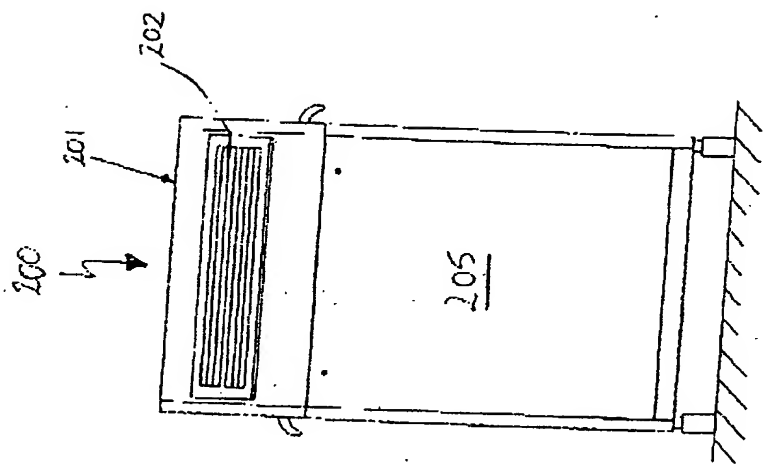

FIGURE 4B

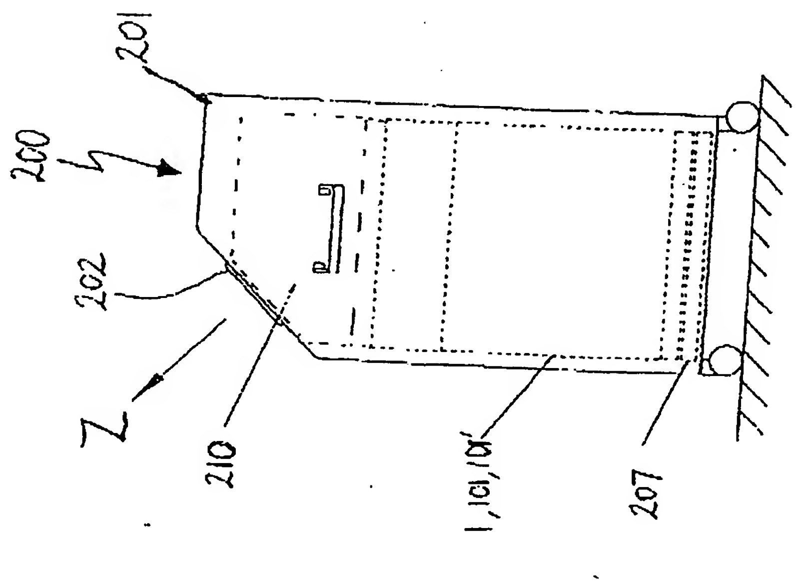

FIGURE 4A

Agent's Ref: P03986GB

CONTROL OF ENVIRONMENT

The invention relates to the control of an environment, for example by the exclusion of airborne pathogens in the working zone in an operating theatre.

According to the invention in one aspect there is provided apparatus comprising a chamber having an inlet and an outlet for passage of air therethrough, a plurality of UV light sources to irradiate the interior of the chamber, a conduit means leading from the outlet to a hood adapted to be held above a working table.

Preferably the apparatus includes a conduit leading to the inlet, the entry point for the conduit being located at a level below the working table and in vertical alignment with the hood, to collect air emerging from the hood and pass it back into the apparatus.

Preferably the hood is shaped so that the downwardly flowing air is caused to undergo a laminar flow.

In a preferred application the working table is an operating table in a hospital theatre, but it may be any other support such as a hospital bed, a doctors surgery examination table, a table in mortuary, or the like.

Preferably, a shield member is present about each light source to reduce deposition of airborne detritus on the UV light source.

Preferably each shield member is made of a UV transparent material. Preferably the

UV transparent material is made or quartz or fused silica. Preferably each shield member is a tube disposed about the UV light source. Preferably each shield member is detachable from the light source for cleaning purposes.

Preferably, the UV light sources are UV lamps, emitting light in the UV-C band (typically 254 nm). Suitable UV lamps are elongate tubes, it has been found that for good effect the lamps should have a non-circular cross-sectional shape, say oval with flats. This increases the effective area of radiation. Preferably the lamps are arranged in banks, say each of four lamps. Preferably the mean level of radiation is about 10 milliwatts.

The chamber may comprise one or more walls which comprise a UV reflective surface, such as quartz mirrors, or polished aluminium or the like. One or more walls comprising a UV reflective surface may be shaped to present a concave surface to the flowing air, say to form a parabolic or other reflector.

In one embodiment, the UV light sources extend across the chamber, preferably perpendicular to the intended flow of air, each light source being separated from the chamber by a UV transparent shield member. In other embodiments the light sources are at different inclinations.

In another embodiment the chamber is tubular and the UV transparent shield member is tubular and co-axially mounted within the chamber to define a tubular air flow path, the UV light sources being mounted in the annular space between the chamber and the transparent shield member.

Preferably a heat sink is associated with each light source.

The apparatus may also include first filter means situated across the inlet and, preferably second filter means situated across the outlet. The first filter means may comprise an electrostatic filter element and the second filter means may comprise a HEPA filter element. Extra filter elements may be present at the inlet and/or the outlet.

Preferably one or both of the electrostatic and HEPA filter elements are fabricated from a UV transmitting material. The second filter means may comprise a frame, preferably a combustible frame, such as one fabricated from wood, a derivative of wood or the like.

A component made of a material which releases hydroxyl ions known to be detrimental to pathogens may be present. Such a material may be a metal oxide such as titanium dioxide.

The apparatus may further comprise turbulence inducing means, arranged to induce turbulence in air flowing through the chamber. The turbulence inducing means may comprise a fixed blade fan or baffles located downstream or upstream of the inlet. The UV transparent shield member may comprise the turbulence inducing means.

The invention will now be described, by way of example only, and with reference to the accompanying Figures in which:

Figure 1 is an elevation of a hospital operating theatre incorporating a unit of the invention;

Figure 2 is a perspective view of a first embodiment of air cleaning apparatus in the unit of Figure 1;

Figure 3A is an elevation of a second embodiment of air cleaning apparatus for the unit of Figure 1;

Figure 3B is a view along line A - A of Figure 3A;

Figure 4A is an elevation of a variation of the second embodiment of air cleaning apparatus of Figures 3A and 3B;

Figure 4B is a view along line B-B' of Figure 4A;

Figure 5A is a side elevation of a unit shown in Figure 1;

Figure 5B is a front elevation of the unit of Figure 5A; and

Figure 5C is a plan view of the unit of Figure 4.

As shown in Figure 1, an operating theatre contains an operating table T on a floor F. The usual ancillary equipment is not shown. Within the theatre is a portable air cleaning unit U. This is described in greater detail in Figures 5A to 5C below. The unit contains apparatus according to Figures 2 to 4, which will be described later.

The top of the unit U is connected via a flexible conduit Cu to a hood H above the table T. A conduit Ct is connected to an air collection trough A on the floor F in vertical alignment with the hood H. The hood is shaped so that downwardly flowing air is caused to flow in a laminar fashion.

Referring to Figure 2, there is shown air cleaning apparatus 1 for mounting in the unit U and having a chamber 2 in which is located a series of quartz sleeves 3 (13 being shown, but the number may be raised, and range from say 8 in two banks each of 4 lamps). A UV-C lamp 4 is located within each sleeve 3. At one end of the chamber 2 there is mounted an electrostatic filter 5 across the inlet to the chamber 2. Below the filter 5 is a UV screen 9. The filter is arranged to give particles a static charge. At the other end of the chamber 2, across the outlet thereof, there is mounted a HEPA filter 6.

The lamps are arranged to emit light in the UV-C band of about 254 nm. The output is about 10 milliamps/cm^2 mean level, and a heat sink is present to keep the temperature at about 100^{0}C.

Two opposed walls 20, 21 of the chamber 2 have a concave inner surface, the other two walls 22, 23 being planar. Walls 20, 21 are formed from, have applied thereto, or are coated with aluminium, which is polished or shiny to enhance the UV reflectivity of the walls 20, 21. The planar side walls are similarly treated.

In use, air is drawn or pushed through the apparatus in the direction of arrow X by fan means (not shown). Thus, air is pre-filtered by the electrostatic filter 5 to remove relatively large particulate material and enters the chamber 2 where it is irradiated by the UV-C lamps 4. It will be appreciated that the UV-C radiation is emitted through 360° and, because of the number and arrangement of the lamps, maximum irradiation of the incoming air is ensured. The UV-C light is also reflected from the walls 20, 21, 22, 23 to ensure complete irradiation of the space defined by the walls 20, 21, 22, 23. The concave surfaces of walls 20, 21 act as parabolic reflectors to the UV-C radiation. The radiation cannot escape from the chamber, so reducing the risk of injury to an operator.

As the air is drawn or pushed through the chamber the transported viruses, mould and bacteria are killed or rendered inert by the actinic radiation.

The electrostatic filter may be formed of a UV transmissible material. It may also have one or both of its major surfaces coated with an anti-microbial or biostat substance.

After passing through the UV irradiation zone, the air is finely filtered by the HEPA filter 6. Any organisms which have not been affected by the UV-C radiation, are trapped on or in the HEPA filter 6. The HEPA filter element 61 is preferably made from a UV transmissible material such as glass fibres. Therefore, any trapped bacteria, mould or virus undergoes further irradiation, ensuring that it is rendered non-viable. The HEPA filter element 61 may be held in place by a frame 62. Preferably, the frame 62 is fabricated from a combustible material, such as wood. Once the nominal lifetime of the filter 6 has elapsed, the whole filter 6 may be removed and incinerated. The frame 62 makes it easy for an operator to remove and replace the filter 6. Another filter may be present, e.g. of carbon particles.

During operation of lamps 4, there is a tendency for a static field to build up, which usually attracts dust and dirt particles. These fall on the sleeves instead of on the lamps 4. The sleeves 3 also ensure that a degree of turbulence is induced into the air flowing through the chamber 2.

It will be appreciated that to change a lamp 4 during routine maintenance it is unnecessary to turn off the power to all of the lamps 4. The emissive part of each lamp 4 is within the chamber 2, thus an operator may simply disconnect the power supply to the lamp 4 which is to be changed and slide that lamp 4 out of its respective sleeve 3. The procedure is reversed to install a new lamp. This is advantageous because there is

reduced down-time for the apparatus and during lamp replacement there is a reduced risk of exposure of the operator to UV-C radiation.

During routine maintenance of the apparatus 1, the sleeves 3 may require cleaning. To do so it is necessary to cut off power to the unit 1. The sleeves 3 can then simply be removed and wiped clean.

It is a feature of the invention that when the apparatus is switched off the lamps are energised for about 5 minutes and continue to operate after the fan is switched off. This reduces the risk of injury to the operator. Dual safety circuits and UV-C protected inspection windows are present to confirm that lamps are switched off.

Figures 3A and 3B show a second embodiment of air cleaning apparatus 101 having a chamber 102 mounted within which elongate UV-C lamps 104 (8 being shown), are circumferentially spaced about the inner periphery of the chamber 102, with their axes parallel to that of the chamber 102. A quartz sleeve 103 is mounted co-axially within the chamber 102, the lights being located between the sleeve 103 and the wall of the chamber 102. If it is desired that a greater intensity of UV light is to be directed to the centre of the chamber 102, a quartz focussing lens 110 may be located adjacent each lamp 104.

An electrostatic filter 105 is mounted across the inlet to the chamber 102. At the other end of the chamber 102, a HEPA 106 extends across the outlet.

The internal surface 123 of the wall of the chamber 102 is formed from, is coated with, or has placed thereupon aluminium, which is polished.

Mounted upstream of the electrostatic filter 105 is a fixed blade fan 130. The fan 130 induces turbulence in any air which flows thereby.

In use, air is drawn or pushed through the apparatus 101 in the direction of arrow Y by fan means (not shown). Thus, air is pre-filtered by the electrostatic filter 105 to remove relatively large particulate material. The air passes by the fan 130 which induces turbulence in the air flow, which air then enters the chamber 102 where it is irradiated by the UV-C lamps 104. The UV-C light is also reflected from the walls 123 to ensure complete irradiation of the space defined by the sleeve 103. As the air is drawn or pushed through the chamber 102 viruses, mould and bacteria are killed or rendered inert by the actinic radiation.

The electrostatic filter 105 may be formed of a UV transmissible material such as glass fibres. It may also have one or both of its major surfaces coated with an anti-microbial biostatic coating.

After passing through the UV irradiation zone, the air is finely filtered by the HEPA filter 106. Any viable mould, bacteria or viruses which have not been killed by the UV-C radiation, will be trapped on or in the HEPA filter 106. The HEPA filter element 161 is preferably made from a UV transmissible material such as glass fibres. Therefore, any trapped bacteria, mould or virus undergoes further irradiation, ensuring that it is rendered non-viable. The HEPA filter element 161 may be held in place by a frame 162. Preferably, the frame 162 is fabricated from a combustible material, such as wood. Once the nominal lifetime of the filter 106 has elapsed, the whole filter 106 may be removed and incinerated. The frame 162 makes it easy for an operator to remove and replace the filter 106, and aids in the incineration process.

During operation of lamps 104, there is a tendency for a static field to build up, which usually attracts dust and dirt particles. The sleeve 103 prevents the build up of dust or other detritus on the lamps 104.

Figures 4A and 4B show a variation of the apparatus of Figures 3A and 3B, wherein identical components are indicated by the same numerals with the addition of a prime (')..

The apparatus 101' has all of the components previously described with the exception of the lamps 104. In the apparatus 101', a series of toroidal or omega shaped lamps 204 (8 shown) are located along the major axis of the chamber 102' in the space defined between the quartz sleeve 103' and the inner wall of the chamber 102'. As will be appreciated, operation of apparatus 101' accords with that of 101.

The apparatus 1, 101, 101' may be used to clean air in a fixed system, such as those used in buildings, vehicles and the like, wherein air from, say, a room is exhausted via ducting which is connected to the inlet of the apparatus 1, 101, 101'. The so-cleaned air is then returned to the, say, room either directly or via a further air conditioning plant, for example a heat exchanger to warm or cool the air.

Several air-cleaning apparatus 1, 101, 101' may be connected in parallel so that cleaning or routine maintenance of one may be carried out whilst the others are operating.

The apparatus 1, 101, 101' may also be used in a portable air-cleaning unit 200, as shown in Figures 5A, 5B and 5C. The unit 200 has a housing 201 in which is located the air cleaning apparatus 1, 101, 101' according to the invention. Fan means 210 is located within the housing 201 adjacent the outlet of the apparatus 1, 101, 101' to draw dirty or

un-purified air through the apparatus 1, 101, 101' and expel cleaned air in the direction of arrow Z via a grille or screen 202.

A power supply will be provided to power the various components of the unit 200. A logic circuit device may be present to detect dirty filters, component failure, power interruption, and the like and to cause a fail safe shut down.

The unit 200 may have a baffle 207 mounted within the housing 201 adjacent the inlet of the apparatus 1, 101, 101' to prevent any UV-C radiation form exiting the housing 201.

Preferably, the unit 200 will be provided with sensors to monitor the pressure drop across the filters of apparatus 1, 101; 101'. As the pressure drop increases it is evidence that a filter element is becoming occluded with matter. The signals from the sensors can be compared with pre-calibrated readings to enable a micro-processor or other comparitor to activate a warning signal when the filter or filters require replacement. The unit may also have sensors to monitor the output of the lamps to activate a warning signal upon failure of the lamps. A lamp-lifetime countdown timer may also be provided to monitor the time of use of the lamps. An access panel 205, which affords access to the apparatus 1, 101, 101' may be interlocked to the energy source for the lamps. Thus, opening the panel will cause the energy supply to the lamps to be interrupted.

The unit 200 may be provided with fan means to push air through the apparatus 1, 101, 101'. Any suitable device may be used , such as a fan or other device known to be useful in moving air.

The apparatus 101, 101' need not have a fixed blade fan 130, 130'. Other baffle arrangements may be provided or turbulence inducing means may be omitted.

The apparatus of the invention 1, 101, 101' is space-efficient, effective in destroying potential pathogens and in cleaning air. The presence of a plurality of light sources, each being shielded from the direct flow of the air confers many advantages. The apparatus may be retro-fit into existing air-cleaning apparatus.

In use, the unit U is activated and air is passed therethrough to destroy airborne pathogens. The cleaned sterile air exits via the conduit C; to the hood H and then downwardly in laminar flow over the operating table T. In this way the working zone is kept sterile. The air is then collected in the floor level through A and recycled via the unit U.

The invention is not limited to the embodiments shown. Baffles may be present to prevent UV radiation leakage such as a UV screen at the inlet and the outlet. A carbon filter may also be present at the outlet. Devices to generate ozone, electronic controllers may be present to monitor the temperature of the lamps and intensity.